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Clinical comparison of short and conventional implants placed in the posterior region of the mandible. A pilot study

Comparação clínica de implantes curtos e convencionais instalados na região posterior da mandíbula. Estudo piloto

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Resumo

Objetivo: Avaliar e correlacionar os valores de densidade óssea radiográfica, altura óssea peri-implantar e de frequência de ressonância nos implantes curtos e convencionais instalados na região posterior da mandíbula após a instalação da prótese provisória. **Material e método:** Esse estudo piloto clínico prospectivo contou com a participação de 11 pacientes que foram divididos previamente em dois grupos: implantes curtos (n=18) (5,0 x 5,5 mm e 5,0 x 7,0 mm) e implantes convencionais (n=23) (4,0 x 10 mm e 4,0 x 11,5 mm). Foram executadas análise da frequência de ressonância, altura óssea e densidade óssea peri-implantar. Os implantes foram avaliados nos períodos T0 (imediatamente após a instalação do provisório), T1 (após 90 dias) e T2 (após 180 dias). **Resultado:** Não houve diferenças estatisticamente significativas entre os grupos com relação a densidade óssea radiográfica (152,50 ± 15,39 vs. 157,60 ± 28,46, para implantes convencionais e curtos respectivamente no período T2), estabilidade dos implantes (Implantes convencionais: 66,76 ± 10,39 no período T0 e 61,85 ± 8,38 no período T2 vs. Implantes curtos: 57,50 ± 12,17 no período T0 e 61,53 ± 7,39 no período T2) e quanto a perda óssea periimplantar (0,03 mm vs. -0,17 mm, em implantes convencionais e curtos no período T2, respectivamente). Adicionalmente a isso, não foram detectados correlação significativa entre densidade radiográfica com altura óssea peri-implantar e nem com a frequência de ressonância. **Conclusão**: Verificou-se que os implantes curtos apresentaram um comportamento semelhante aos implantes de comprimento convencionais com relação à frequência de ressonância, a densidade radiográfica peri-implantar e a manutenção dos níveis ósseos periimplantares.

Descritores: Reabsorção óssea; densidade óssea; próteses e implantes.

Abstract

Objective: To evaluate and correlate the values of radiographic bone density, peri-implant bone height and resonance frequency analysis (RFA) of short or conventional implants placed in the posterior region of the mandible after installing a prosthesis. **Material and method:** Eleven patients were selected for this prospective parallel pilot study. The prostheses were supported by two types of implants: short implants (n = 18) (5.0 x 5.5 mm and 5.0 x 7.0 mm) and conventional implants (n = 23) (4.0 x10 mm and 4.0 x 11.5 mm). The implants were evaluated by RFA, by measuring the bone height, and peri-implant bone density. The implants were evaluated at the periods T0 (immediately after installation of the prosthesis), T1 (after 90 days), and T2 (after 180 days). **Result:** There were no statistically significant differences between groups with respect to radiographic bone density (152.50 ± 15.39 vs. 157.60 ± 28.46, for conventional and short implants, respectively at T2), stability of the implants (Conventional implants: 66.76 ± 10.39 at T0, and 61.85 ± 8.38 at T2 vs. Short implants: 57.50 ± 12.17 at T0, and 61.53 ± 7.39 at T2) and peri-implant bone loss (0.03 mm vs.-0.17 mm, for conventional and short implants, respectively at T2). Additionally, a significant correlation between the evaluated parameters was not detected. **Conclusion:** The short and conventional implants presented similar stability, bone level and density after the activation of occlusion loading.

Descriptors: Bone resorption; bone density; prostheses and implants.

INTRODUCTION

Dental implants have been used predictably for the treatment of all forms of edentulism[1,2]. However, anatomical conditions such as bone atrophy create technical difficulties for the installation of implants of a conventional size[3,4].

Techniques such as guided bone regeneration, inlay block grafts[5], sinus floor augmentation[6], osteodistraction[7], and lateralization of the inferior alveolar nerve[8] have been proposed for individuals with decreased bone height and thickness to allow for placement of a conventionally sized implant. These techniques are more complex and are rarely accepted by patients due to risks such as increased morbidity, surgical time and the extra costs for implant-supported rehabilitation[9,10].

One alternative that has been proposed is the use of short implants that would have the advantage of eliminating additional surgical procedures to increase bone availability following installation of the implants[6,11]. A literature review reports that previous studies have shown that the use of short implants had a high failure rate compared to conventional implants[12]. However, with the improvement of engineering materials, there have been changes in the external/internal design and the surface of the implant that have allowed treatment with short implants to obtain success rates similar to the use of conventional implants[6]. In addition, there is also contradictory information regarding success rates (e.g. prosthetic complications, marginal bone loss) of short implants. One study showed that success rates of short implants installed in the posterior region of the jaws were 65.2% after a follow up of 16 to 57 months, which is lower than expected for conventional implants in this same type of situation[13]. On the other hand, a clinical study that evaluated the success rates of short and conventional implants placed in fully edentulous mandibles and followed up for 12 months showed an equal success rates for these both types of implants[14].

Considering that short implants may interfere with the success and survival of the oral rehabilitation, the aim of this study was to evaluate and compare the values of radiographic bone density, peri-implant bone height and resonance frequency analysis of short and conventional implants installed in the posterior region of the mandible after installation of the temporary implant-supported prosthesis.

MATERIAL AND METHOD

Patient Selection

This prospective parallel study was approved by the Ethics Committee on Human Research (1302/11) and was conducted in accordance with the Declaration of Helsinki. Patients were asked respectfully to participate in this study and signed an informed consent before they were included in the study.

Eleven patients were selected for this study. Eight of them were female and three were male, and the mean age of participants was 53.44 years. The exclusion criteria adopted for this study were 1) presence of systemic alterations; 2) chronic use medications that alter bone metabolism; 3) smoking; 4) alcoholism; and 5) presence of parafunctional habits.

Two types of implants were placed in these patients, and the selection was defined according to the tomographic analysis of the posterior region of the mandible: Group I: Short Implants (5.0 x 5.5 mm and 5.0 x 7.0 mm); Group II: Conventional implants (4.0 x 10 mm and 4.0 x 11.5 mm). The short implants were placed in areas with a distance from the alveolar crest to the upper wall of the mandibular canal of less than 11.5 mm (Short, Conexão implant Systems), whereas the conventional implants were installed in areas where this distance exceeded 11.5 mm (Master Grip, Conexão implant Systems). All the implants were installed by the same operator.

Prosthetic Rehabilitation

All patients received a provisional prosthesis for four months after the implant placement. Micro-Unit abutments were installed to permit the connection of multiple screw-retained prostheses (Conexão implant Systems). The provisional acrylic prostheses were fitted using Micro Unit intermediaries. All the prostheses were installed by the same operator.

Radiographic Analysis (Bone Level and Density)

The radiographic analyses were performed using a digital periapical radiograph of each implant (Gendex®). A device made of acrylic resin (Figure 1A) (Jet Clássico) was used to standardize the radiographic position to ensure the cone of the X-ray apparatus was perpendicular to the digital film, which eventually became parallel to the long axis of the implant (Figure 1B-F). All radiographs were performed using the same X-ray device (Gnatus) with the same exposure parameters: 65-90 Kv, 7.5-10 mA and a controlled time of 0.2s.

For the analysis of peri-implant bone level, the images were graded according to the length of the implant, and the measurements were made using the superior portion of the implant platform as a reference point for the bone contact with the implant body. Regarding the analysis of the bone density, five areas with 20x20 pixels were defined, four of them were delimited to the side regions of the implant (coronal and the middle third region of the implants) and the implant body (Figure 1G). The radiographic density calculations were performed using the average gray levels of the regions of interest, which were defined from the implant gray tone to compensate for minor differences between x-rays because the density of the metallic pattern of the implant was the same in all samples. Radiographs were assessed at periods T0 (immediately after installation of the interim), T1 (after 90 days) and T2 (after 180 days). These analyses were performed using image analysis software (Image J, National Institutes of Health) by a single calibrated examiner.

Resonance Frequency Analysis (RFA)

The RFA was made with an Osstell® apparatus (Osstell), which is an apparatus using transducers connected to the implant or prosthetic components available for many systems. The transducers (smartpegs) induce a lateral force to the fixed components, and the

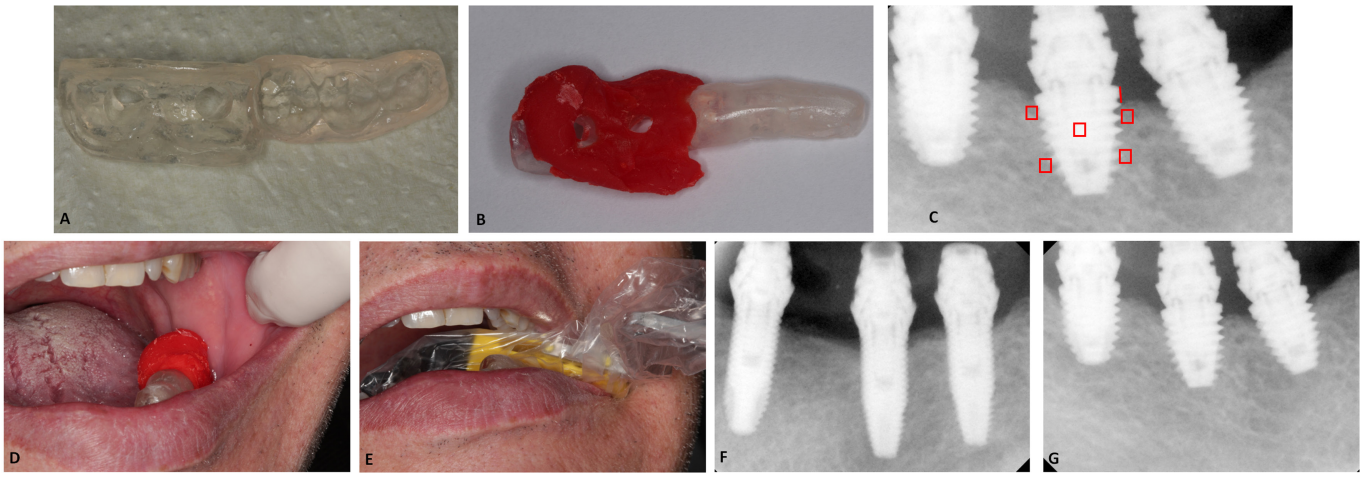

Figure 1. (A) Image showing the acrylic device used to standardized the radiography position; (B) Acrylic device with wax that allows the fixation of the guide on the implants; (C) Acrylic device positioned in the patient's mouth; (D) Placement of the radiographic device on the acrylic device; (E) Conventional implants installed; (F) Short implants installed; (G) Red line-Analysis of the bone level (distance between the implant platform and the bone-implant contact), Red squares- Five areas with 20x20 pixels were defined, four of them were delimited to the side regions of the implant (coronal and the middle third region of the implants) and the implant body. The radiographic density calculations were performed using the average gray levels of the regions of interest, which were defined from the implant gray tone to compensate for minor differences between x-rays because the density of the metallic pattern of the implant was the same in all samples.

displacement of the system is measured. The value obtained with the Osstell® was automatically translated into an implant stability quotient (ISQ) that ranged from 1 to 100. The smartpeg A3, which is coupled to the system unit with torque from 4 to 6 N.cm, was used for this evaluation. The measurements were made in the mesial, distal, buccal and lingual areas, and the average of these values was considered the final value for RFA for each implant.

Statistical Analysis

The numerical data of all the parameters analyzed in this study were subjected to a Shapiro-Wilk normality test ($p > 0.05$), which determined the application of parametric tests for inferential analysis. The unpaired t-test was used to compare the different types of implants in each evaluation period, whereas the repeated measurements one-way ANOVA test was used to assess intra-group data. Additionally, the Pearson correlation test was used to evaluate the correlation of bone density, bone level and RFA data. GraphPad Prism 5 software was used to perform statistical analysis, and all tests were applied with a confidence level of 95% ($p < 0.05$).

RESULT

A total of 41 implants were installed in 11 patients. Of this total, 18 were short implants and 23 were conventional implants. No implants were lost during the evaluation period of this study.

Bone Density

In the analysis of the bone radiographic density, no statistically significant differences between the groups were detected for any of the evaluated periods. There were also no differences among the groups for the different periods of evaluation. Even by segmenting the evaluation of bone radiographic density into cortical and medullary areas, there were not statistically significant between-group differences in any of the evaluation periods. Within the group with conventional implants, there was a reduction in bone radiographic density in the period T1 compared to the period T0 ($p < 0.05$). The average and standard deviation data of the radiographic density analysis for all of the groups is included in Table 1.

Bone Level

Analysis of the bone level showed that the short implants had a lower distance between the implant platform and the bone crest compared to conventional implants for all of the evaluation periods (1.87-1.95 mm for conventional implants vs. 0.51-0.68 mm for short implants) ($p < 0.05$). Additionally, there were no intra-group differences regarding bone level variation during the experimental period. However, the variation of the bone loss between the groups were not different (0.05 mm at T1 and 0.03mm at T2 for conventional implants vs. -0.08 mm at T1 and -0.17 mm at T2 for short implants). Table 1 shows the average and standard deviation of the bone level (mm) for all of the groups.

RFA

The RFA showed that the conventional implants (66.76 ± 10.39) presented greater stability values compared to the short implants (57.50 ± 12.17) during the T0 period ($p < 0.05$). However, this difference was not detected in other periods. Regarding the intra-group analysis, there was a reduction in the stability of conventional implants in the T2 period compared to the T1 period ($p < 0.05$) and an increase in stability of the short implant in the T1 period compared to the T0 period ($p < 0.01$). Table 1 shows the average and standard deviation of the RFA for all of the groups.

Correlations

A negative correlation was found between the bone level and RFA data in the conventional implant group T0 period ($p = 0.04$). With respect to the correlation between the bone level and bone

radiographic density data, this correlation was not statistically significant. For the correlation data between the bone radiographic density and the RFA, a negative correlation was detected for short implants only detected in period T1 (p = 0.04). Table 2 shows the values of the correlations performed in this study.

DISCUSSION

Areas with severe bone resorption and limitations in bone height and thickness represent a challenge for oral rehabilitation with dental implants[11,14], especially in the posterior regions of the mandible and maxilla where the mandibular canal and maxillary sinus floor are located[6,15]. Short implants have emerged as a less traumatic and invasive alternative than reconstructive procedures with bone grafts[6,14,15]. However, despite the good predictability and high success rate of bone grafting procedures, patients are often reluctant to undergo additional surgeries because of the risks and morbidity associated with them[15].

Loss of implants after the installation of the provisional implant-supported prosthesis did not occur in our study. Although it has been stated that the short implants presented a higher failure rate than conventional implants[12], some authors showed a survival rate for short implants ranging from 87.5%-100%[6,11,16,17], and this rate was very similar to the survival rate for conventional implants fitted in native bone areas[14] or grafted areas[6,15]. This rate was confirmed by this study, although the follow-up time was short (6 months after installation of the prosthesis).

It was shown in this study that short implants have lower distance between the implant platform to the bone crest compared to conventional implants. However, these results do not represent greater vertical bone loss in the group with conventional implants, because that differences already occurred in T0. The absence of differences in bone loss around conventional implants and short implants has also been reported in other studies[6,14]. One clinical study with higher follow-up time than this study showed that short-implants have cumulation bone loss of 0.3 ± 0.5 mm at 48 months. These authors showed that the crow- implant ratio is one of the parameters that significant influence the bone loss in short implants[13]. The effect of this parameter in long-term evaluated should be better estimated.

Finite element studies have shown that the increase in diameter of the implant causes a better distribution of masticatory stress[18,19] and improves primary stability[14,20]. However, this trend was not observed in our study, although the short implants were 5 mm in diameter while the conventional implants were 4 mm in diameter.

Another important factor that can influence the bone level data is that although both implants present a switching platform, the short implants presented a higher rate of mismatch between the abutment and the implant platform (0.525 mm) compared to the conventional implants (0.075 mm). It has been demonstrated that higher mismatching between the abutment and the implant platform reduces bone loss[21] and the occlusal tension around implants[22]. It is likely that the short period of evaluation in our study did not allow for identification of major changes at the peri-implant bone level.

The implant stability analysis demonstrated that the conventional implants had higher RFA values in the immediate period after installing the prosthesis. However, with the establishment of stability after application of occlusal loads, there were no differences of this parameter between the implants. The conventional implant was greater in length than the short implant, and consequently presented an increased contact area with the bone tissue that may have been responsible for greater stability prior to the provisional prosthesis installation[20]. However, there has also been a progressive increase in the stability of the short implant and a reduced stability of conventional implants, and this increase may be related to the fact

Table 1. Average and standard deviation of the bone radiographic density, bone level and RFA analysis for all of the groups

Analysis	Period	Conventional implants	Short Implants
Bone radiographic density	T0	159.40±21.03	167.90±13.08
	T1	141.10±42.03	163.80±27.90
	T2	152.50±15.39	157.60±28.46
Bone level	T0	1.87±0.91	0.68±1.32**
	T1	1.95±0.87	0.60±0.91***
	T2	1.90±0.91	0.51±0.77***
RFA	T0	66.76±10.39#	57.50±12.17
	T1	68.10±4.88	68.02±7.19
	T2	61.85±8.38	61.53±7.39

**p<0.01; ***p<0.001-Bone level was statistically inferior compared to conventional implants according to an unpaired t-test; # RFA was statistically superior compared to short implants implants according to an unpaired t-test.

Table 2. Correlation values for bone level/RFA/bone density data (p values) for all of the groups and assessment periods and the aggregated results

Analysis	Implants	T0	T1	T2	General
Bone level/RFA	Conventional implants	-0.44(0.04)	-0.21(0.35)	-0.23(0.31)	-0.28(0.02)
	Short implants	0.11(0.67)	-0.15(0.57)	0.21(0.43)	0.05(0.71)
Bone level/Bone density	Conventional implants	-0.31(0.15)	0.21(0.33)	0.07(0.74)	0.02(0.83)
	Short implants	-0.31(0.24)	0.34(0.19)	0.20(0.45)	0.15(0.28)
RFA/Bone density	Conventional implants	0.01(0.96)	0.16(0.47)	-0.18(0.41)	-0.01(0.91)
	Short implants	-0.14(0.58)	-0.51(0.04)	-0.18(0.50)	-0.24(0.10)

that short implants with larger diameter may reduce the intensity of stress transmitted to the surrounding bone[19,20], which suggests that the conventional implants applied a higher tension to the surrounding bone that could induce increased bone turnover and consequently reduce the stability values.

The values of bone radiographic density showed no statistically significant difference between the implants, even when the different bone regions were compared (cortical and medullary). These data show that the implants were installed in areas that had similar bone density that was not altered by the osseointegration process and prosthetic loading of the implants. A study that evaluates the effects of progressive occlusal loading of the implants compared to conventional loading demonstrated that different types of prosthetic loading presented no difference in bone radiographic density around the implant[23]. This outcome suggests that after the osseointegration period, if prosthetic principles are respected, the occlusal load will not promote changes in the peri-implant bone even around implants with different heights and diameters.

Although the parameters analyzed in this study are factors that influence the success rates of implants[24], none of the parameters showed a statistically significant correlation. One of the reasons for this lack of correlation is that increased bone density probably did not influence the increased contact between the implants and the bone, which may have made the correlation between the bone density and RFA and the bone level very weak[25]. In addition, it has been demonstrated that the peri-implant bone level was not influenced by bone density[26]. Moreover, it is possible that the low number of implants evaluated in this study and the short follow-up period may have influenced the absence of significant differences between short and conventional implants for the parameters that were evaluated. Another limitation of this study was that the crown-implant ration was not measured, and this parameter is an important variable for understanding the results of long-term evaluations. New long-term studies need to be performed to consolidate the functional outcomes for short implants either with a temporary or definitive prosthesis.

CONCLUSION

Given the methodology used and the results obtained, it can be concluded that 1) short implants had similar results compared to conventional-length implants; 2) there was no significant correlation between the parameters of radiographic density, implant stability and the height of the peri-implant bone.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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